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Province of British Columbia
Ministry of Energy, Mines and
Petroleum Resources
Hon. Jack Weisgerber, Minister

MINERAL RESOURCES DIVISION
Geological Survey Branch

SCHEDULE OF SERVICES

ANALYTICAL SCIENCES LABORATORY

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VICTORIA
BRITISH COLUMBIA
CANADA

JULY 1991

FORWORD

.....The beginnings of many an eminent mine arose from a kindled fire and a look into the bottom of a little crucible.....

Since 1897, the Analytical Sciences Laboratory has provided expertise and service in the analysis of rocks, ores and minerals to the Ministry of Energy, Mines and Petroleum resources. Over its illustrious 94-year history the Laboratory has served the Ministry well by providing over one and a half million individual elemental determinations; certifying hundreds of assayers and by developing a number of innovative sample preparation, analysis and interpretation techniques.

In 1897, only a handful of elements were determined whereas today much of the periodic table is possible. Today, as in 1897, the requirement of the Laboratory to provide accurate and reliable results is never more applicable.

This Schedule of Services has been written to inform Geological Survey Branch staff and other Ministry users of the span of services available from the Analytical Sciences Laboratory.

The Schedule explains the procedure for submitting samples to the Laboratory using the new "Request for Services" form, reviews the in-house and commercially available multi-element analytical packages and describes other services offered by the Laboratory such as lapidary and X-Ray diffraction.

Since the services will be provided this year on a user-pay basis, the cost of these services is also given in the Schedule. Additionally, the appendices of this document contain such useful information as the Laboratory's inventory of standard reference materials, geochemical values for elements in a number of the more common standards and a guide to average elemental abundances in crustal rocks. Frequent additions to the Schedule are planned. Among these will be issues of *The Crucible*, the Laboratory Newsletter, notes written to accompany seminars on analytical topics delivered from time to time by laboratory staff and more detailed information on analytical methods commonly employed in mineral analysis. Lastly, the Laboratory staff welcome comments from users on the content of the existing Schedule and suggestions for improvements and additions.

Paul F. Matysek
Chief Assayer

May 21, 1991

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PART 1 - INTRODUCTION

THE ANALYTICAL SCIENCES LABORATORY

Responsibilities and aims of the Analytical Sciences Laboratory are as follows:

1) Providing Geological Survey Branch users with timely, high quality analytical data at a reasonable cost and to offer expertise on analytical and general chemistry.

2) Directing research into geochemical problems and developing new analytical methods.

3) Administering the Certification of Assayers Program, a rigorous practical and theoretical examination which all British Columbia assayers and mineral analysts must pass in order to practice in the Province. This program has existed for almost a century and has been responsible for the high quality of commercial analyses in the Province and the readily available pool of standards provided by the laboratory for examination purposes.

4) Producing Open File publications from archived geochemical data and thin section descriptions.

5) Informing Geological Survey Branch staff of new analytical methods and techniques.

Presently the Analytical Sciences Laboratory routinely performs rock sample comminution, mineral separation, X-Ray Diffraction and analysis of samples for carbon and sulphur and for other elements by X-Ray Fluorescence and Atomic Absorption Spectrophotometry. It also provides volumetric and gravimetric analyses as a more specialized service. An indication of the number of samples analysed in recent years and the type of analyses performed on each sample is illustrated in Table 1.

Beginning this year new services are being introduced reflecting the changing role of the Analytical Sciences Laboratory within the Geological Survey Branch. By combining in-house and commercially available analyses the laboratory will offer a wider range of services such as instrumental neutron activation (INAA) and inductively coupled plasma emission spectroscopy (ICP-ES). This strategy reflects the ever increasing role of rock geochemistry in the solution of geological problems and a stronger measure of confidence in high quality data produced cost effectively by commercial analytical laboratories.

The new analytical techniques have dramatically increased the number of elements which can be measured at greatly improved detection limits. Equally vital to these developments is the need for an adequate suite of reference materials to monitor the quality of the data produced by these methods. The Laboratory is responsible for critically evaluating geochemical results produced commercially using data for standard reference materials and at the same time producing in-house standards suitable to improve the quality control scheme.

Although many elements can now be determined commercially the Analytical Sciences Laboratory will still continue to carry out such analytical services as sample preparation and quality control because certain key analytical tasks should be under the direct control of Laboratory staff.

USER PAY SCHEME

A **User Pay** scheme will be introduced this year to cover part of the Laboratory's operating costs. You will note that charges have been established for all in-house and commercial analytical services and for lapidary work. Also, the costs for in-house services are lower than for commercial services. While users will now have to budget for these services there will clearly be an even greater emphasis on the laboratory to provide users with timely, high quality data. The Laboratory will negotiate the most advantageous rates for analytical work through commercial laboratories and will apply careful quality control procedures before releasing data from commercial laboratories to users. All in-house and commercially generated quality control data will be available for review by users.

SCHEDULE OF SERVICES

This Schedule of Services has been designed for Analytical Sciences Laboratory users with the object of providing clear instructions for submitting samples and requesting analyses. It also describes the in-house and commercially available analytical methods, costs and quality control procedures. Clearly a Manual of this scope has room for improvement and expansion as different analytical methods can be evaluated and additional services can be added. The Schedule will be updated frequently and the Laboratory welcomes comments from users to assist in this updating process.

TABLE 1

ANALYTICAL REQUESTS 1986-1990

ELEMENT	1986	1987	1988	1989	1990	TOTAL	AVERAGE/ YEAR
As	1046	924	1405	1012	1208	5595	1119
Au	946	1489	1645	1156	823	6059	1212
Ag	857	1467	1616	1160	831	5931	1186
Ba	620	1119	1490	1118	877	5224	1045
Bi	298	316	253	203	183	1253	251
CO_2	518	768	1131	523	672	3612	722
Co	387	742	822	475	426	2852	570
Cr	351	963	1603	846	661	4424	885
Cu	995	1621	1716	1212	1028	6572	1314
FeO	388	768	1139	555	635	3485	697
Hg	751	548	909	693	649	3550	710
LOI	471	1025	1260	569	685	4010	802
Nb	233	860	680	534	561	2868	574
Ni	553	1115	1674	930	676	4948	990
Mo	604	1090	1207	768	480	4149	830
OXIDES	695	1050	1152	555	685	4137	827
Pb	984	1367	1715	1167	925	6158	1232
Prep.	582	2411	3039	2138	1631	10801	2160
Pt/Pd		159	82	22	6	269	54
REES	48	477	435	334	162	1458	291
Rb	67	598	477	1050	477	2669	534
S	419	780	1183	490	629	3501	700
Sb	817	786	1390	947	481	4421	884
Sr	340	857	1361	1118	815	4491	898
Sn	61	123	107	73	49	413	83
Ta	27	651	754	171	494	1917	383
Te	80	61	130	19	81	371	74
V		462	219	610	456	1747	349
W	16	132	301	29	71	549	110
Y	233	1190	772	552	574	3321	664
Zn	984	1517	1730	1167	882	6280	1256
Zr	238	857	695	508	577	2875	575

BEFORE YOU COLLECT THE SAMPLES ----

There will be two general types of analytical requests.

In-house analytical requests are those which will be handled completely by the Geological Survey Branch Analytical Sciences Laboratory.

Commercial analytical requests are those involving the transfer of analytical work to commercial laboratories. These requests usually require the determination of elements or elements packages not available in-house or require unusually rapid turnaround.

When submitting samples for both in-house and commercial requests the following guidelines should be used:

a) **Determine Analytical Needs**

Before the field season, estimate your analytical requirements. Discuss options for special and routine requests with the Laboratory staff. In"WHO TO TALK TO" and Figure 1 the Laboratory's organizational structure is shown and the expertise of the individual staff members summarized.

b) **Review Fee Schedules/purchase order conditions for information on commercially available analyses**

Since analytical costs will be charged to your project budget (**User Pay System**) carefully review your budget, your analytical needs and the prices listed in this Schedule. Purchase Orders have been established at several approved commercial laboratories who have passed our data quality and reliability test program. A summary of the services available at laboratories is given in Appendix 1. Information on other commercial laboratories providing specialised services can be obtained if requested.

WHEN YOU COLLECT THE SAMPLES----

a) **Check Sample Size**

Make certain that there is sufficient material for all of the determinations you plan to have made on the sample. For major and trace element analyses 10-20 g of prepared pulp is needed and therefore a 500 g sample of the rock or soil is adequate. However, if a gold analysis or assay is needed a 1000 g sample should be collected since a larger sample is required for the determination. Discuss sample size with laboratory staff if you have doubts. There are many publications describing sample collection, sample preparation, dissolution methods and analytical techniques. Among the more general are those by Merks (1985), Fletcher (1981), Johnson and Maxwell (1981), Jeffery (1975) and Hutchinson (1974). These references, listed at the end of this Schedule, are available for review in the Laboratory library. The Laboratory library also has many of the current Journals on analytical chemistry and a wide range of other relevant publications on chemical topics.

b) **Include Field Duplicates**

It is advisable that five per cent of your samples are field duplicates to establish sampling variability. This may be difficult if rocks are very coarse textured, altered or mineralized. However, quality control data generated by the analysis of the field duplicates can be valuable for establishing the combined sampling-analytical error. The laboratory is responsible for inserting blind analytical duplicates and standard reference material after the samples have been received.

c) **Complete the Request for Analysis Form**

A new multiple copy Analytical Request Form has been produced and an example is shown in Appendix 3. The new form allows entry of sample identification, NTS Map number, UTM coordinates, sample type and rock formation code in a similar manner to the old request form. One copy should be kept by the geologist as a record of the samples sent and the request. The object of the new form is to simplify completion and at the same time allow for collection of key information necessary to produce lithogeochemical Open Files on an annual basis. **Final reports will not be released unless this information has been recorded on the form.** The open file will release analytical data for the preceding Calendar year to aid Geological Survey Branch users in publishing results. The analyses requested by the User are identified by a simple code explained later in this Schedule.

d) **Information needed to Complete the Form.**

THE CLIENT is responsible for entering sample numbers, rock formation code, sample type, services requested, the response number, account number and **Spending Authority** (if possible).
Copy 1 of the Form is kept by the Client and copy 2 is sent with the samples to the Analytical Sciences Laboratory.

THE LABORATORY will then assign a Laboratory Number to each sample and a Sample Batch Number, enter the information into the TRACK system, check the costs on the Form, issue an Invoice and send it to the appropriate Section Administrative Assistant.

THE SECTION ADMINISTRATIVE ASSISTANT will assign a Budget Commitment Number to the Sample Batch identified on the invoice, obtain or confirm the Spending Authority, forward the Commitment Request to the Budget Clerk and return the Original Form to the Laboratory.

THE LABORATORY will complete the analysis, send a report to the client and make certain the Form is sent to the Environmental Geology Administrative Assistant.

THE ENVIRONMENTAL GEOLOGY ADMINISTRATIVE ASSISTANT will arrange for the transfer of funds from the appropriate Section Account into the Laboratory Account by Journal Voucher.

e) Ship samples

Ship samples with a copy of the Analytical Request Form to the Analytical Sciences Laboratory. Printed Shipping labels and plastic or cloth samples bags will be provided if needed. All sample shipments should be prepaid. If possible the Laboratory should be informed when sample shipments are sent and by what route so that a follow-up can be initiated if the shipment goes astray. **Please do not send samples to a Bus depot for pick-up.**

Depending on the location of the field project there are several options for shipping the samples.

i) **Canada Post** - Slow, but low cost;

ii) **Canada Freightways** - Most economical for large shipments;

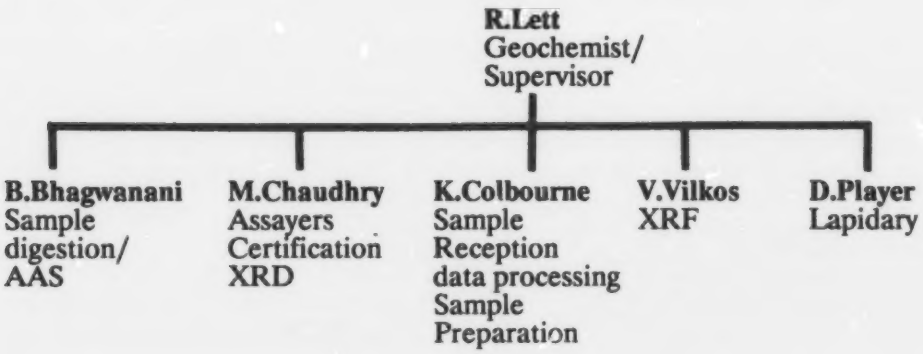
iii) **Purolator** - More expensive, but fast;

iv) **Bus Parcel Post** - Less expensive than couriers, **but no delivery;**

WHO TO TALK TO----

FIGURE 1

ANALYTICAL SCIENCES LABORATORY
ORGANIZATIONAL STRUCTURE



Staff

Ray Lett (356-2134)	Laboratory supervision quality control, advice and research.
Bish Bhagwanani (356-2135)	Sample digestion,atomic absorption, carbon-sulphur analysis methods research.
Mac Chaudhry (356-2133)	Assayers Certification Program, XRD, Acid Mine Drainage Research.
Kathy Colbourne (356-2134)	Sample Reception, Preparation Data Processing and Reporting. Sample digestion and fusions AA methods.
Verna Vilkos (387-5756)	XRF, methods research, standards calibration.
Dick Player (387-6758)	Lapidary, thin and polished sections, Photography.

TRACING YOUR SAMPLES----

Kathy Colbourne will be happy to inform you of the status and progress of your analytical request. In addition a monthly status report will be made available for review. Invariably, some of the elements requested will be finished before others and a partial analytical report will be released. At the same time the flow chart will be updated to reflect completion of the elements. (*See* Section on "SAMPLE TRACKING"). A copy of the Flow Chart is included in Appendix 4.

LAST BUT NOT LEAST-----

You will receive a hard copy of the analytical report containing the analytical data, quality control data and details of the analytical method. The Laboratory will include a laboratory duplicate and a control reference standard (Certified if possible) in each batch of twenty samples submitted for analysis. Smaller batches will also have a duplicate and standard. If requested, literature geochemical data for the standard can be included with the report. In addition to the hard copy report, the data can be loaded onto a floppy diskette in ASCII, dBASE III+ or LOTUS formats.

PART 2 - SERVICES

INTRODUCTION

The Analytical Sciences Laboratory performs **ALL** sample preparation for Ministry users. The main stages of sample preparation and analysis are summarized in Figure 2. All of the analytical methods described in this Schedule are identified with a code number to simplify completion of the Analytical Request Form.

SAMPLE PREPARATION

ROCK SAMPLE COMMINUTION - Packages ASL 1 and ASL 2

The Laboratory has two separate rock sample comminution facilities to minimize contamination of unmineralized materials by mineralized rocks. Samples are separated into the two groups based on the information given in the Analytical Request Form. Mineralized and unmineralized samples are jaw crushed, split and ring mill pulverized to smaller than 100 mesh at separate locations. Samples for mineral separation are also crushed, sieved and treated with heavy liquids to separate density fractions. Further separation into mineral fractions for isotopic analysis is carried out by the geologist submitting the samples.

Ring pulverization can be carried out in either a chrome steel mill (ASL1) or in a tungsten-carbide mill (ASL2). Both mills introduce variable (Fe, Cr, Co, Ta, W) contamination depending in part on the hardness of the sample. A guide to the amount of trace element contaminant introduced during preparation is given by data from analysis of the quartz blanks used to clean the mill between each sample.

Cost/sample $2.25 Average turnaround 30 samples/day

MINERAL SEPARATION FOR AGE DATING

Samples are crushed, sized and washed in a water column. Magnetic, isodynamic and heavy liquid separations are used to concentrate the mineral of interest. Extensive hand picking is occasionally needed to remove impurities which cannot be separated using standard techniques. This step is generally carried out by the geologist.

Cost/sample Upon Request

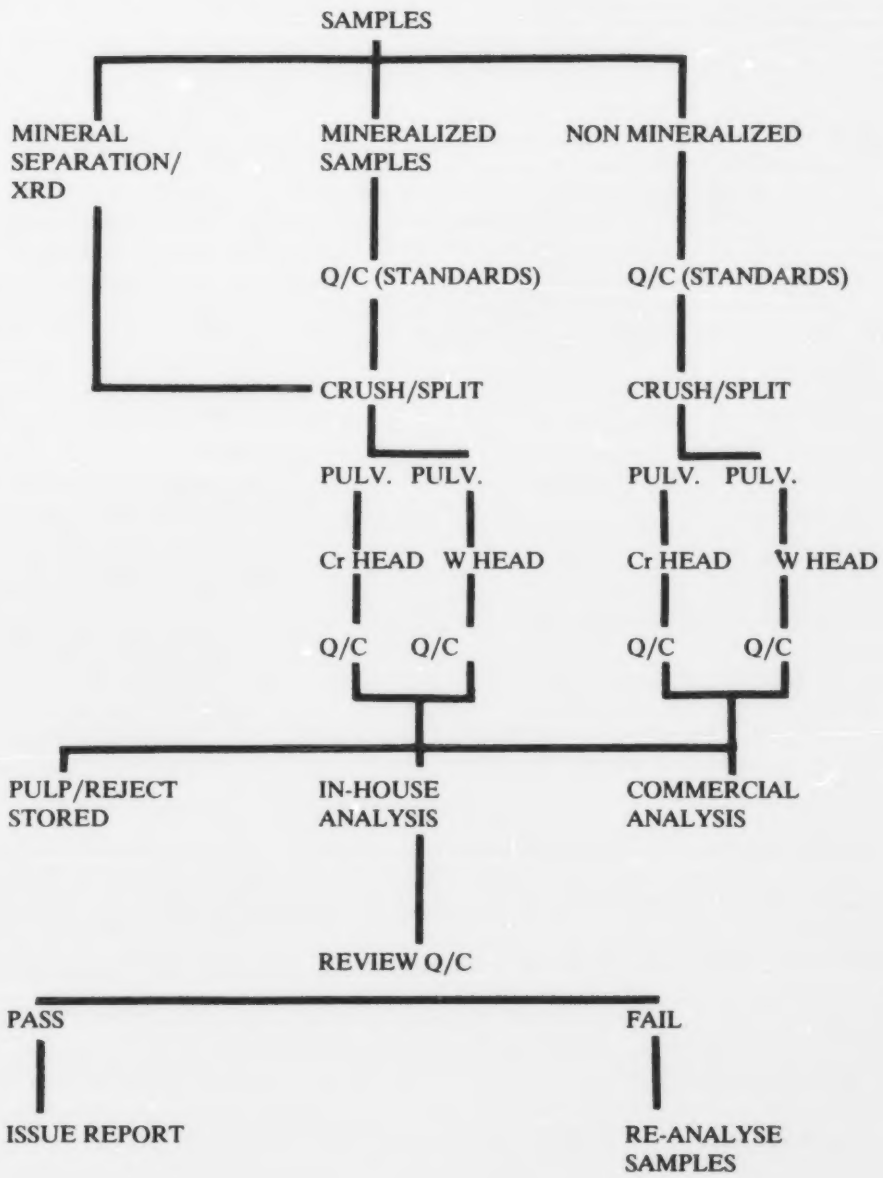
PREPARATION OF SOILS AND SEDIMENTS - Package ASL 3

Because there is limited space in the Laboratory, drying of soils and sediments must be carried out before samples are sent for analysis. Dried soils and sediments will be disagregated and sieved through a stainless steel or nylon screen. The available sieve mesh sizes range from 20 (0.1mm) to 230 (063 mm). Grain size analysis can also be carried out if requested.

Cost/sample	$0.50
Grain size Analysis	On Request

FIGURE 2

FLOW DIAGRAM FOR THE ANALYTICAL SCIENCES LABORATORY



IN-HOUSE ANALYTICAL SERVICES

MAJOR OXIDE AND LOSS ON IGNITION ANALYSES - Package ASL 4

Major oxides, SiO_2, Al_2O_3, Fe_2O_3, MgO, CaO, Na_2O, K_2O, TiO_2, MnO, P_2O_5 are determined by X-Ray Fluorescence with a Philips PW1404 automated spectrometer. A 2 g aliquot of the sample pulp is mixed with 10 g of a flux comprising 80 per cent lithium tetraborate and 20 per cent lithium metaborate and fused in a platinum crucible to prepare a glass disc. A primary X-Ray beam, directed onto the disc, excites elements to emit secondary X-Ray fluorescence. Discrimination between elements based on their characteristic frequency is performed by X-Ray diffraction. The intensity of the fluorescence is measured by gas filled proportional or scintillation counters.

Calibration of the X-Ray fluorescence spectrometer is performed using rock and mineral standards. Because of the different rock types commonly analysed it is essential to use as wide a range of different standard as possible for calibration. Matrix variations such as particle size, variable background, line overlap and absorption edge interference can influence the quality of the final data. Mathematic corrections are therefore made to compensate for these variables.

IMPORTANT NOTE: Samples with high copper (>500 ppm), magnesium carbonate, industrial materials, and iron are difficult to fuse. Silver and gold will alloy with platinum to damage the crucibles. If the laboratory is unable to fuse a sample it will be treated as a "special request" and a higher charge will be applied for the work. Please discuss possible "problem" samples with Laboratory staff before submitting them for analysis for major oxides and trace metals.

Average turnaround	20 samples/day
Precision(%RSD)	<1
Cost/Sample	$10.00

TRACE ELEMENT ANALYSIS BY XRF - Package ASL 5

"Total" trace element contents are determined by X-ray Fluorescence using a fused disc prepared by the same method as for major oxides. Different software is used to apply corrections necessary to calculate trace metal concentrations. Some of the trace metals are determined with the chromium target while others are measured with a gold target. Normal detection levels for trace elements measured with the two targets are given in Table 2.

Average turnaround	20 samples/day
Precision(%RSD)	<5
Cost/sample (all elements)	$25.00
Cost/element	$3.00

IMPORTANT NOTE ON TRACE ELEMENT ANALYSIS
Development work is still in progress on the analysis for Sn, Th, Ta, U, and W by XRF. Exact detection levels are not presently available (NA), but usually range from 2-50 ppm. Please discuss with laboratory staff before you request these elements.

TABLE 2
DETECTION LEVELS FOR TRACE ELEMENTS DETERMINED BY XRF

GOLD TARGET		CHROMIUM TARGET	
ELEMENT	DETECTION LIMIT(PPM)	ELEMENT	DETECTION LIMIT(PPM)
Cr	10	Ba	10
Nb	5	Ce	15
Rb	10	Cs	5
Sr	5	La	15
Sn	NA	Sc	3
Th	NA	Ti	10
Ta	NA	V	5
U	NA		
W	NA		
Y	10		
Zr	20		

TRACE METAL (Ag, Cu, Pb, Zn, Co, Ni, Mo, Mn, Fe, Cd, Bi, As, Sb, Li) ANALYSIS - Package ASL 6

"Total" copper, lead, zinc, cobalt, nickel, silver, molybdenum, iron, cadmium, bismuth, arsenic, antimony, manganese, and lithium are determined by hot concentrated nitric-perchloric-hydrofluoric acid digestion followed by atomic absorption spectrophotometry. Detection levels for the elements determined are given in Table 3.

TABLE 3
DETECTION LEVELS FOR TRACE ELEMENTS DETERMINED BY AAS

ELEMENT	DETECTION LIMIT(PPM)	ELEMENT	DETECTION LIMIT(PPM)
Cu	2	Pb	4
Zn	2	Co	3
Ni	5	Mo	8
Fe	5	Mn	5
Ag	0.5	Li	2
Cd	0.5	Bi	5
As	70	Sb	20

Average turnaround	30 samples/day
Precision(%RSD)	<8
Cost/sample (All elements)	$10.00
Cost/sample (Single element)	$2.00

ARSENIC, ANTIMONY AND MERCURY ANALYSIS
Package ASL 7

"Total" arsenic, antimony and mercury are also determined by hot concentrated nitric-perchloric-hydrofluoric acid digestion followed by hydride generation atomic absorption spectrophotometry (As, Sb) or cold vapour atomic absorption spectrophotometry (Hg). The detection level for arsenic and antimony is 1 ppm and for mercury, 0.02 ppm.

Average turnaround	30 samples/day
Precision(%RSD)	<8
Cost/sample (All elements	$5.00
Cost/sample (Single element)	$2.00

BASE METAL ASSAY - Package ASL 8

A base metal (*e.g* copper, lead) assay can be carried out if specifically requested or if laboratory staff detect more than 0.2 per cent sulphur in the sample. The analytical method used for base metal assay is essentially the same as for trace determination. Some of the assays are carried out by gravimetric-volumetric technique.

Average turnaround	30 samples/day
Precision(%RSD)	<5
Cost/sample (Single element)	$5.00

LOSS ON IGNITION - ASL 9

A 0.5 g aliquot of the sample is weighed into a tared crucible, heated at 1050^{o}C for 3-4 hours and the weight loss reported as Loss on Ignition (LOI).

Average turnaround	50 samples/day
Precision(%RSD)	<5
Cost/sample	$3.00

DETERMINATION OF WATER - ASL 10

A 1 g aliquot of the sample is weighed into a tared weighing bottle, heated to 105^{o}C to a constant weight and the weight loss reported as H_2O^- (moisture)

Average turnaround	50 samples/day
Precision(%RSD)	<5
Cost/sample	$3.00

ANALYSIS FOR CARBON - ASL 11 AND SULPHUR - ASL 12

Carbon and sulphur are determined separately by a volumetric and titrimetric method with a Leco induction furnace system. A 0.5 g aliquot of the sample is employed. Detection levels are 0.04 per cent for carbon and 0.01 per cent for sulphur.

Average turnaround	30 samples/day
Precision(%RSD)	5
Cost/sample(S **OR** C)	$5.00

ANALYSIS FOR IRON (FeO) - ASL 13

A 1 g aliquot of the sample is heated in a closed platinum crucible with sulphuric and hydrofluoric acids. The solution is neutralized with boric acid and the dissolved ferrous iron oxidized and measured by potassium permanganate titration. The detection limit for FeO is 0.04 per cent.

Average turn-around	25 samples/day
Precision(%RSD)	5
Cost/sample	$5.00

X-RAY DIFFRACTION ANALYSIS - ASL 14

Starting this year some of the routine X-Ray diffraction analysis will be carried out by other organizations able to provide this service (*e.g.* UBC Geological Sciences Center). Presently the sample preparation, preliminary mineral identification, X-ray diffraction analysis and interpretation is carried out in the Analytical Sciences Laboratory. The new service would involve off-site X-Ray diffraction analysis, but the interpretation still being performed in-house. **In order to make this service most cost effective users should examine samples before analysis, record the mineralogy and rock type on the sample request form and discuss the samples with M. Chaudhry.**

Average turnaround	5-7 days
Cost/sample(diffractogram)	$10.00
Cost/**hour**(Interpretation)	$20.00

LAPIDARY SERVICES - ASL 15 AND PHOTOGRAPHIC SERVICES - ASL 16

The lapidary laboratory has both 24 and 8 inch diamond saws, thin and polished section preparation equipment and pneumet presses. Photographic services are also provided through the lapidary section. The lapidary also plans to establish a central library for thin sections and at the same time a digital database where key information on the characteristics of each section (rock type, location, mineralogy) will be stored.

Cost/thin section	$4.00
Cost/**hour** for photography	$15.00

COMMERCIAL ANALYTICAL PACKAGES

GOLD BY FIRE ASSAY - CA 1

A 20 or 30 g (one assay ton) aliquot of the prepared sample is mixed with litharge and fused in a fire clay crucible. The lead button produced is separated from the silicate slag and cupelled to recover to gold-silver Dore' bead. For gold concentration above 200 ppb the silver in the bead is dissolved in warm, dilute nitric acid and the annealed bead weighed on a sensitive balance. Gold concentrations as low as 1 ppb are determined by dissolving the bead in warm, dilute nitric and hydrochloric acids and analysing the solution by either flame AAS, graphite furnace AAS or ICP-ES.

Average turnaround	4-5 days /batch (100 to 200 samples)
Precision(%RSD)	10-50 (depending on sample size)
Cost/sample	$8.00

GOLD PLUS 34 ELEMENTS BY NEUTRON ACTIVATION - Package CA 2

A 30 g sample (one assay ton) is encapsulated in a PVC vial and irradiated in a nuclear reactor. Element concentrations are measured by counting the short lived decay products. Depending on the irradiation time, counting time and other factors elements can be determined with different detection limits. Package **CA2** represents an economical, multielement analysis suitable for routine gold exploration. Detection limits for the elements are given Table 4.

Average turnaround	15 days/batch
Precision(%RSD)	variable depending on element
Cost/sample	$12.00

TABLE 4

DETECTION LEVELS FOR ELEMENTS BY NEUTRON ACTIVATION (30 g)

ELEMENT	DETECTION LIMIT(PPM)	ELEMENT	DETECTION LIMIT(PPM)
Ag	5	As	2
Au	5 ppb	Ba	100
Br	1	Ca	1%
Ce	5	Co	5
Cr	10	Cs	2
Eu	0.2%	Fe	0.02%
Hf	1	Hg	1
Ir	1	La	1
Lu	0.05	Mo	5
Na	0.05%	Nd	5
Ni	50	Rb	30
Sb	0.2	SC	0.1
Se	5	Sr	0.05%
Sm	0.1	Sn	0.01%
Ta	1	U	0.5
Th	0.5	W	4
Zn	50	Yb	0.2

TRACE ELEMENTS AND RARE EARTHS BY NEUTRON ACTIVATION - Package CA 3. RARE EARTHS AND ACTINIDES ONLY - CA 4

The same method is used to determine up to 52 trace elements and rare earth metals in rocks using a 1 g aliquot. This method is unsuitable if a reliable measurement of gold is needed because of the small sample size. The high cost for the analytical package reflects the low detection limits obtained for the elements. The greater analytical sensitivity makes this package more suitable for research purposes. Detection limits for Package CA3 are given in Table 5.

Average turnaround	15 days/batch
Precision(%RSD)	variable (generally <5% for REES)
Cost/sample(all elements-CA 3)	$70.00
Cost/sample(REE & actinides only-CA 4)	$60.00

NOTE: For Dy to be included add $15.00 to price.

TABLE 5

DETECTION LEVELS FOR ELEMENTS BY NEUTRON ACTIVATION (1 g)

COMMON MINOR AND TRACE METALS

ELEMENT (Trace)	DETECTION LIMIT(PPM)	ELEMENT	DETECTION LIMIT(PPM)
Ag	2	As	1
Au	2ppb	Ba	20
Br	0.5	Ca	0.2%
Co	0.1	Cr	0.5
Cs	0.2	Fe	0.005%
Hf	0.2	Ir	1 ppb
Mo	2	Na	0.001%
Ni	50	Rb	10
Sb	0.1	Se	0.5
Sr	100	Ta	0.3
W	1	Zn	10

RARE EARTH AND ACTINIDE ELEMENTS

ELEMENT	DETECTION LIMIT(PPM)	ELEMENT	DETECTION LIMIT(PPM)
Sc	0.01	La	0.1
Ce	1	Nd	3
Sm	0.01	Eu	0.05
Tb	0.1	Yb	0.05
Lu	0.01	U	0.1
Th	0.1	Dy	0.5

TRACE METALS BY INDUCTIVELY COUPLED PLASMA EMISSION SPECTROSCOPY - Package CA 5

A 0.5 g aliquot of the sample is digested in aqua regia and metals determined by ICP-ES. Examination of data for certified standards analysed by this method reveals that concentrations of metals such as arsenic and copper approach the certified levels, but that values for metals such as calcium, strontium, cobalt, nickel and zinc are much lower than those in the standard. Since this is a partial method the analytical data produced should not be compared directly with results of XRF or other "total" methods. Detection levels are given in Table 6.

Average turnaround	10 days/batch
Precision(%RSD)	variable
Cost/sample	$5.00

TABLE 6
DETECTION LEVELS FOR ELEMENTS BY AQUA REGIA-ICP-ES

ELEMENT	DETECTION LIMIT(PPM)	ELEMENT	DETECTION LIMIT(PPM)
Ag	0.1	As	2
Al	0.01%	Cd	1
Au	2	Ba	2
B	2	Ca	0.01%
Co	1	Cr	1
U	5	Fe	0.01%
K	0.01%	La	2
Mg	0.01%	Mo	1
Mn	1	Pb	2
Na	0.01%	Ni	1
P	0.01%	Sb	2
Sb	2	Sr	1
Ti	0.01%	V	2
Th	2	W	2

ARSENIC, ANTIMONY, TELLURIUM, SELENIUM ANALYSIS - Package CA 6

A 0.5 g aliquot of the sample is digested in aqua regia, the elements reduced to their hydride form with sodium borohydride and measured by ICP-ES. The detection level for all elements is 0.1 ppm. Germanium and bismuth can also be determined in this package

Average turnaround	10 days/batch
Precision(%RSD)	5
Cost/sample	$6.00

ANALYSIS FOR METALS IN WATER BY ICP-ES - Package CA 7

A wide range of elements such as calcium, magnesium, sodium, aluminium, silica, iron, manganese, copper, cadmium, lead and zinc in raw and filtered (0.45 micron) water samples can be determined ICP-ES. However, detection levels by this method may be too high if water chemistry data is needed for environmental evaluation studies. Alternatively, copper, lead, zinc, cadmium, arsenic, iron, manganese and other elements can be measured by atomic absorption. Detection levels in the 10-20 ppb range can be obtained with flame AAS. Lower detection levels in the 1-2 ppb range are possible using graphite furnace AAS.

Cost/sample (ICP-ES)	$5.00

QUALITY CONTROL

Quality control involves routine analysis of standards, sample replicates and samples blanks at intervals of one standard/replicate/blank in each batch of 20 samples analysed in-house and through commercial facilities. Every effort is made to match the sample matrix with that of the standard. Analytical data for Standards is routinely plotted on Shewhart control charts to monitor quality control and to detect analytical bias. The laboratory presently has over 200 different standards ranging from relatively common ones such as CANMET rocks and sediments to rather rare materials. A list of the more common standards and information on their general characteristics is given in Appendix 2.

In addition to Certified Standard Reference Materials (which are expensive) the Laboratory is in the process of preparing additional rock standards which will be calibrated using the Certified Standards. The quality control data is included with each report.

SAMPLE TRACKING

The Analytical Sciences Laboratory is equipped with a computer-based sample tracking system which allows the status of a particular analytical request to be quickly determined at any stage by inspection of a flow chart (*See* Example in Appendix 4). From the flow chart the user can establish the number and identity of the samples submitted, the elements or services requested, those elements or services completed and the analyst. Any user can request a copy of a flow chart for the current year and for an individual request. Copies of flow charts for 1985-1989 are also available for inspection in the laboratory.

SAMPLE STORAGE

Sample pulps and their crushed coarse fraction will be retained in the laboratory for a maximum of one year. Samples will be then transferred to the storage facility and held for two years after which time they will be discarded. A storage charge for samples this should be recognized when budgeting for analysis.

OTHER SERVICES

Other analytical and support services are available through commercial laboratories and other agencies, but are not described in this Schedule. For additional services consult the Laboratory staff.

1991-1992 FEE SCHEDULE

IN-HOUSE SERVICES

PARAMETER	PACKAGE CODE	IN-HOUSE COSTS (/SAMPLE)	AVERAGE COMMERCIAL COSTS
PREP.(CR HEAD)	ASL1	$2.25	$4.50
PREP.(W HEAD)	ASL2	$2.25	$4.50
PREP.(SOIL)	ASL3	$0.50	$1.00
OXIDES	ASL4	$10.00	$25.00
TRACE METALS(XRF)	ASL5	$25.00	$50.00
TRACE METALS(AAS)	ASL6	$10.00	$22.00
HYDRIDE METALS/HG	ASL7	$5.00	$15.00
BASE METAL ASSAY	ASL8	$5.00	$15.00
LOSS ON IGNITION	ASL9	$3.00	$7.50
WATER (LOSS ON DRYING)	ASL10	$3.00	$7.50
CARBON	ASL11	$5.00	$10.00
SULPHUR	ASL12	$5.00	$10.00
FeO	ASL13	$5.00	$8.75
XRD (Analysis)	ASL14	$10.00	$25.00
XRD (Interpretation)		$20.00(/hr)	$30.00
THIN SECTIONS	ALS15	$4.00	$8.50
PHOTOGRAPHY	ASL16	$15.00(/hr)	
SAMPLE STORAGE		$0.14	

COMMERCIAL SERVICES

GOLD (FIRE ASSAY)	CA1	$8.00
GOLD +34 TRACE(INAA)	CA2	$12.00
TRACE METALS+REE BY DNAA	CA3	$70.00
REE & ACTINIDES BY DNAA	CA4	$60.00
TRACE METALS BY ICP-ES	CA5	$5.00
As,Sb,Te,Se	CA6	$6.00
METALS IN WATER	CA7	$5.00

IMPORTANT NOTE: While every effort will be made to establish firm commercial prices at the start of the Fiscal year, they are subject to change.This is beyond the Control of the Analytical Sciences Laboratory.

APPENDIX 1

SUMMARY OF SERVICES PROVIDED BY COMMERCIAL ANALYTICAL LABORATORIES

The Analytical Sciences Laboratory has established Open Purchase Orders with a number of Commercial Laboratories. The Services provided by these laboratories are summarized below. More detailed information on these services can be obtained from the Fee Schedules and Brochures for individual laboratories on file in the Analytical Sciences Laboratory. A list of the laboratories and their PO numbers will accompany this Schedule. Not all of the commercial laboratories offering services have been listed here and their omission in no way reflects on their capabilities or reliabilities.

LABORATORY	SUMMARY OF SERVICES
ACME ANALYTICAL 852 E Hastings St. VANCOUVER, B.C. V6A 1R6 Ph.(604) 253-3158 Fax(604) 253-1716 Contact Clarence Leong	Precious Metals Assay Multi-elements by ICP-ES
ACTLABS 1336 Sandhill Dr. ANCASTER, Ontario L9G 4V5 Ph.(416) 648-9611 Fax(416) 648-9613 Contact Eric Hoffman	Neutron Activation for rocks, heavy minerals vegetation. Rare Earth Analysis
ASSAYERS GROUP 705 W. 15TH St. NORTH VANCOUVER, B.C. V7A 1T2 Ph.(604) 980-5814 Fax(604) 980-9621 Contact Jack Stanley	Precious Metals Assay Multi-elements by ICP-ES Major Oxides by ICP-ES
BONDAR CLEGG 130 Pemberton Ave. NORTH VANCOUVER, B.C. V7P 2R5 Ph.(604) 985-0681 Fax(604) 985-1071 Contact Russ Calow	Precious Metals Assay Multi-elements by ICP-ES Major Oxides by XRF Neutron Activation Environmetal analysis

CHEMEX LABS
212 Brooksbank Ave.
NORTH VANCOUVER, B.C.
V7J 2C1
Ph.(604) 984-0221
Fax(604) 984-0218
Contact Lloyd Twaites

Precious Metals Assay
Multi-elements by ICP-ES
Major Oxides by XRF
Neutron Activation
Environmental Analysis

ECO-TECH
10041 E. TRANS
Canada Highway
KAMLOOPS, B.C.
V7C 2J3
Ph.(604) 573-5700
Fax(604) 573-4557
Contact Clint Ayers

Precious Metals Assay
Muti-elements by ICP-ES
Major oxides by ICP-ES
Environmental Analysis

XRL (SGS)
1001 E. PENDER ST.
VANCOUVER, B.C.
V6A 1W2
Ph.(604) 254-1647
Fax(604) 573-4557

Precious Metals Assay
Muti-elements by ICP-ES
Major oxides by XRF
Environmental Analysis
XRD

APPENDIX 2

INVENTORY OF STANDARD REFERENCE MATERIALS AVAILABLE AT THE ANALYTICAL SCIENCES LABORATORY AND USABLE VALUES FOR ELEMENTS IN SOME COMMON STANDARDS

ANALYTICAL SCIENCES LABORATORY INVENTORY OF STANDARDS

LAB #	STANDARD NAME	SOURCE	MATERIAL OR ROCK TYPE	# GRAMS IN STOCK
1	BAM 827-1	GERMANY		80
2	BCS-381	BRITAIN	BASIC SLAG	80
3	BCS-382	BRITAIN	BASIC SLAG	80
4	CRM-879-1	BRITAIN	BASIC SLAG	80
5	SO-2	CANMET	SOIL	450
6	SO-3	CANMET	SOIL	550
7	NBS-120B	USA	PHOSPHATE ROCK	30
9	SY-3	CANMET	SYENITE	350
10	NBS-70A	USA	K-FELDSPAR	50
11	NBS-88A	USA	DOL. LST	20
12	ASK-2	NORWAY	SCHIST	15
13	GXR-1	USA-USGS	JASPEROID	450
14	GXR-2	USA-USGS	SOIL	350
15	GXR-3	USA-USGS	HOT SPRING DEPOSIT	350
16	GXR-4	USA-USGS	CU MILL HEAD	300
17	GXR-5	USA-USGS	SOIL	150
18	GXR-6	USA-USGS	SOIL	300
19	JB-1	JAPAN	BASALT	25
20	JG-1	JAPAN	GRANODIORITE	20
21	MRG-1	CANMET	GABBRO	650
22	SY-2	CANMET	SYENITE	600
23	NBS-69B	USA	BAUXITE	50
24	NBS-91	USA	OPAL GLASS	40
25	NBS-98A	USA	PLASTIC CLAY	40
26	NBS-99	USA	SODA FELDSPAR	5
27	NBS-99A	USA	SODIUM FELDSPAR	20
28	NBS-1635	USA	TRACE METALS IN COAL	50
29	NBS-1632	USA	TRACE METALS IN COAL	50
30	NBS-329	USA	ZINC CONCENTRATE	100
31	NBS-330	USA	COPPER ORE	100
32	NBS-25C	USA	MANGANESE ORE	100
33	NBS-333	USA	MOLYBDENUM CONC.	200
34	NBS-137	USA	TIN CONCENTRATE	100
35	NBS-113	USA	ZINC CONCENTRATE	100
36	SDC-1	USA-USGS	MICA SCHIST	110
37	MAG-1	USA-USGS	MARINE MUD	120
38	W-2	USA-USGS	CENTERVILLE DIABASE	140
39	BIR-1	USA-USGS	ICELANDIC BASALT	110
40	DNC-1	USA-USGS	N. CAROLINA DIABASE	110
41	SCO-1	USA-USGS	CODY SHALE	120
42	SGR-1	USA-USGS	GREEN RIVER SHALE	110
43	STM-1	USA-USGS	NEPHELINE SYENITE	110
44	QLO-1	USA-USGS	QUARTZ LATITE	110
45	BHVO-1	USA-USGS	HAWAIIAN BASALT	110
46	RGM-1	USA-USGS	GLASS MTN. RHYOLITE	110
47	G-2	USA-USGS	ANALYSED GRANITE	70
48	BCSS-1	CAN.-NRC	MARINE SEDIMENT	150
49	MESS-1	CAN.-NRC	MARINE SEDIMENT	100
50	GSD-1	CHINA	STREAM SEDIMENT	10

LAB #	STANDARD NAME	SOURCE	MATERIAL OR ROCK TYPE	# GRAMS IN STOCK
51	GSD-2	CHINA	STREAM SEDIMENT	10
53	GSD-3	CHINA	STREAM SEDIMENT	10
54	GSD-4	CHINA	POND SEDIMENT	10
55	GSD-5	CHINA	POND SEDIMENT	10
56	GSD-6	CHINA	STREAM SEDIMENT	10
57	GSD-7	CHINA	STREAM SEDIMENT	10
58	GSD-8	CHINA	STREAM SEDIMENT	10
59	BL-1	CANMET	U-TH ORE	50
60	BL-2	CANMET	U-TH ORE	50
61	BL-3	CANMET	U-TH ORE	20
62	BL-4	CANMET	U-TH ORE	150
63	PD-1	CANMET	NON-FERROUS DUST	200
64	HV-1	CANMET	CU-MO ORE	1250
65	PTC-1	CANMET	PT-PD-AU SULPH.CONC.	600
66	PTM-1	CANMET	PT-AU NI-CU MATTE	600
67	LKSD-1	CANMET	LAKE SED. (ONTARIO)	450
68	LKSD-2	CANMET	LAKE SED. (ONT./NWT)	500
69	LKSD-3	CANMET	LAKE SED. (ONT./MAN)	400
70	LKSD-4	CANMET	LAKE SED. (ONT./SAS)	500
71	STSD-1	CANMET	STREAM SED. (ONT.)	500
72	STSD-2	CANMET	STREAM SED. (BC)	425
73	STSD-3	CANMET	STREAM SED. (ONT.)	550
74	STSD-4	CANMET	STREAM SED. (ONT/BC)	500
75	MP-1	CANMET	ZN-SN-CU-PB ORE	120
76	DL-1	CANMET	U-TH ORE	200
77	DH-1	CANMET	U-TH ORE	150
78	RU-1	CANMET	ZN-CU ORE	200
79	OKA-1	CANMET	NIOBIUM ORE	400
80	PTA-1	CANMET	PT BLACK SANDS	500
81	MA-1	CANMET	GOLD ORE	70
82	MA-1B	CANMET	GOLD ORE	600
83	SU-1	CANMET	NI-CU-CO	150
84	GBW 07301	CHINA	SEDIMENT	80
85	GBW 07401	CHINA	SEDIMENT	120
86	GBW 07402	CHINA	SEDIMENT	100
87	GBW 07404	CHINA	SEDIMENT	100
88	SARM 7	S.AFRICA	PLATINUM ORE (SA)	200
89	SARM1(NIM-G)	S.AFRICA	GRANITE	30
90	SARM 13	S.AFRICA	ZIRCON CONCENTRATE	100
91	FER-1	CANMET	IRON ORE	300
92	FER-2	CANMET	IRON ORE	300
93	FER-3	CANMET	IRON ORE	300
94	FER-4	CANMET	IRON ORE	300
95	SCH-1	CANMET	IRON ORE	400
96	SO-1	CANMET	SOIL	200
97	SO-4	CANMET	SOIL	500
98	CD-1	CANMET	ANTIMONY ORE	1400
99	PR-1	CANMET	MO ORE	800
100	GTS-1	CANMET	GOLD TAILING	600

LAB #	STANDARD NAME	SOURCE	MATERIAL OR ROCK TYPE	# GRAMS IN STOCK
101	MA-3	CANMET	GOLD ORE	600
102	MP-1A	CANMET	ZN-SN-CU-PB ORE	1400
103	MP-2	CANMET	W-MO ORE	600
104	KC-1	CANMET	ZN-PB-SN-AG ORE	200
105	KC-1A	CANMET	ZN-PB-SN-AG ORE	1200
106	SU-1A	CANMET	NI-CU-CO ORE	1200
107	SU-2	CANMET	NI-CU-CO ORE	400
108	BL-5	CANMET	U-TH ORE	150
109	DH-1A	CANMET	U-TH ORE	200
110	DL-2	CANMET	U-TH ORE	250
111	UM-1	CANMET	ULTRAMAFIC ROCK	200
112	AGV-1	USA-USGS	ANDESITE	60
113	MA-2	CANMET	GOLD ORE	300
114	NBL 42-1	USA-USDE	PITCHBLENDE-DUNITE	100
115	NBL 42-2	USA-USDE	PITCHBLENDE-DUNITE	100
116	NBL 42-3	USA-USDE	PITCHBLENDE-DUNITE	100
117	NBL 42-4	USA-USDE	PITCHBLENDE-DUNITE	100
118	NBL 74-A	USA-USDE	PITCHBLENDE-DUNITE	50
119	NBL 79-A	USA-USDE		50
120	NBL 80-A	USA-USDE	MONAZITE SAND-DUNITE	50
121	NBL 82-A	USA-USDE	MONAZITE SAND-DUNITE	50
122	NBL-108	USA-USDE	MONAZITE SAND-SILICA	50
123	NBS 1A	USA	ARGILLACEOUS LST.	2
124	NBS 1B	USA	ARGILLACEOUS LST.	2
125	NBS 1C	USA	ARGILLACEOUS LST.	25
126	NBS 27C	USA	IRON ORE(MESABI)	80
127	NBS 27E	USA	IRON ORE	100
128	NBS 29A	USA	IRON ORE(MAGNETITE)	0.5
129	NBS 81	USA	GLASS SAND	50
130	NBS 98	USA	PLASTIC CLAY	2
131	NBS 120A	USA	PHOSPHATE ROCK	5
132	NBS 120C	USA	PHOSPHATE ROCK	100
133	NBS 123B	USA	STEEL	200
134	NBS 136A	USA	POTASSIUM DICHROMATE	30
135	NBS 194	USA	NH4H2PO4	100
136	NBS 200	USA	KH2PO4	100
137	NBS 278	USA	OBSIDIAN ROCK	20
138	NBS 332	USA	COPPER CONCENTRATE	30
139	NBS 84E	USA	ACID K PHTHALATE	15
140	NBS 688	USA	BASALT ROCK	20
141	NBS 696	USA	BAUXITE(SURINAME)	30
142	NBS 697	USA	BAUXITE (DOMINICAN)	30
143	NBS 1632A	USA	COAL (BITUMINOUS)	60
144	NBS 1633	USA	COAL FLY ASH	20
145	NBS 1633A	USA	COAL FLY ASH	100
146	NBS 1645	USA	RIVER SEDIMENT	50
147	NBS 1646	USA	ESTUARINE SEDIMENT	100
148	CCU-1	CANMET	COPPER CONCENTRATE	200
149	CPB-1	CANMET	LEAD CONCENTRATE	500

LAB #	STANDARD NAME	SOURCE	MATERIAL OR ROCK TYPE	# GRAMS IN STOCK
150	CZN-1	CANMET	ZINC CONCENTRATE	400
151	SLG-1	CANMET	BLAST FURNACE SLAG	400
152	NBS 69	USA	BAUXITE	30
153	BCR-1	USA-USGS	BASALT	25
154	DTS-1	USA-USGS	DUNITE	10
155	GSP-1	USA-USGS	GRANDIORITE	10
156	PCC-1	USA-USGS	PERIDOTITE	40
157	CT-1	CANMET	TUNGSTEN ORE	300
158	TLG-1	CANMET	TUNGSTEN ORE	300
159	BH-1	CANMET	TUNGSTEN ORE	400
160	501-726	USA-LECO	BASIC HEARTH SLAG	100
161	501-730	USA-LECO	ACID HEARTH SLAG	100
162	501-733	USA-LECO	ELECTRIC ARC SLAG	100
163	BAM 826-1	GERMANY		100
164	BCS-176	BRITAIN	MANGANESE ORE A	20
165	IRSID 805-1	FRANCE	SO2-1	200
166	IRSID 806-1	FRANCE	SO3-1	200
167	SARM2(NIM-S)	S.AFRICA	SYENITE	10
168	SARM3(NIM-L)	S.AFRICA	LUYAVRITE	20
169	SARM4(NIM-N)	S.AFRICA	NORITE	25
170	SARM5(NIM-P)	S.AFRICA	PYROXENITE	20
171	SARM6(NIM-D)	S.AFRICA	DUNITE	20
172	ASK-1	NORWAY	LARVIKITE	15
173	AN-G	FRANCE	ANORTHOSITE	20
174	BE-N	FRANCE	BASALT	20
175	BR	FRANCE	BASALT	5
176	BX-N	FRANCE	BAUXITE	30
177	DT-N	FRANCE	DISTHENE	40
178	DR-N	FRANCE	DIORITE	30
179	FK-N	FRANCE	FELDSPAR	20
180	GA	FRANCE	GRANITE	30
181	GH	FRANCE	GRANITE	25
182	GL-O	FRANCE	GLAUCONITE	15
183	GNA	GERMANY	GREISER	10
184	GS-N	FRANCE	GRANITE	30
185	MA-N	FRANCE	GRANITE	40
186	T-1	TANGANYI	TONALITE	40
187	UB-N	FRANCE	SERPENTINE	20
188	VS-N	FRANCE	SYNTHETIC GLASS	4
189	W-1	USA-USGS	DIABASE	15
190	NBS-108	USA	MANCOS SHALE	100
191	IGS-20	BRITAIN	NI CONCENTRATE	50
192	IGS-21	BRITAIN	NI ORE(NORITE)	25
192	IGS-22	BRITAIN	NI ORE(SERPENTINITE)	25
193	IGS-22	BRITAIN	NI ORE(SERPENTINITE)	25
194	IGS-23	BRITAIN	NI ORE(LATERITE)	20
195	IGS-24	BRITAIN	CO ORE	15
196	IGS-27	BRITAIN	MO-W PORPHYRY	20
197	IGS-29	BRITAIN	PYROLUSITE	10

LAB #	STANDARD NAME	SOURCE	MATERIAL OR ROCK TYPE	# GRAMS IN STOCK
198	IGS-30	BRITAIN	CHROMITE	15
199	IGS-31	BRITAIN	IIMENITE	25
200	IGS-32	BRITAIN	RUTILE	20
201	IGS-33	BRITAIN	COLUMBITE	20
202	IGS-34	BRITAIN	TANTALITE	20
203	IGS-35	BRITAIN	ZIRCON	35
204	IGS-36	BRITAIN	MONAZITE	35
205	IGS-37	BRITAIN	URANIUM ORE	20
206	IGS-38	BRITAIN	BARYITE	30
207	IGS-39	BRITAIN	FLUORITE	25
208	IGS-42	BRITAIN	PB CONCENTRATE	30
209	IGS-43	BRITAIN	ZN CONCENTRATE	20
210	IGS-44	BRITAIN	CU MATTE	15
211	IGS-45	BRITAIN	CU CONCENTRATE	40

Table 3

Usable Values, "complete analysis" (per cent, dry basis)

	CCRMP								
	Gabbro MRG-1	Bl. Furn. Slag SL-1	Soil SO-1	Soil SO-2	Soil SO-3	Soil SO-4	Syenite SY-2	Syenite SY-3	
SiO_2	39.32	35.73	55.02	53.46	33.93	68.5 ?	60.10	59.68	SiO_2
TiO_2	3.69	0.38?	0.88	1.43	0.32?	0.57	0.14	0.15	TiO_2
Al_2O_3	8.50	9.63	17.72	15.26	5.76	10.32	12.12	11.80	Al_2O_3
Fe_2O_3	8.26						2.28	2.44	Fe_2O_3
FeO	8.63	0.92*					3.62	3.58	FeO
MnO	0.17	0.86?	0.11	0.09	0.07	0.08	0.32	0.32	MnO
MgO	13.49	12.27	3.83	0.90	8.67?	0.93	2.70	2.67	MgO
CaO	14.77	37.48	2.52	2.74	20.7 ?	1.55	7.98	8.26	CaO
Na_2O	0.71	0.39?	2.56?	2.35?	1.00	1.31?	4.34	4.15	Na_2O
K_2O	0.18	0.51?	3.23	2.95	1.40	2.08	4.48	4.20	K_2O
H_2O^+	0.98						0.43	0.42	H_2O^+
CO_2	1.00		4.4 ?[5]	11.5?[5]	25.3 ?[5]	10.4 ?[5]	0.46	0.38	CO_2
P_2O_5	0.06	0.02?	0.14	0.69?	0.11?	0.21	0.43	0.34	P_2O_5
F	0.025		0.07?	0.05?	0.03?	0.03?	0.51	0.66	F
S	0.06	1.26	0.01?	0.03?	0.02?	0.04?	0.011	0.05	S
Others[1]	0.33?	0.01?	0.27?	0.31?	0.10?	0.19?	0.43?	1.18?	Others[1]
Σ	100.18?	99.46?	99.33?	99.69?	99.37?	99.60?	100.35?	100.48?	Σ
O/F, S, Cl	0.04?	See text	0.03?	0.04?	0.02?	0.03?	0.22?	0.31?	O/F, S, Cl
Σ (corr.)	100.14?	?	99.30?	99.65?	99.35?	99.57?	100.13?	100.17?	Σ (corr.)
Fe_2O_3, TR[2]	17.82	1.02	8.57	7.95	2.16	3.39	6.28	6.42	Fe_2O_3, TR[2]
Fe_2O_3, TC[3]	17.85						6.27	6.42	Fe_2O_3, TC[3]

[1] "Trace elements" (see Table 5), converted to oxides, where appropriate.

[2] Total iron, expressed as ferric oxide, derived from reported values for total iron.

[3] Total iron, expressed as ferric oxide, calculated from values derived for ferric and ferrous, based on reported values for ferric and ferrous.

[4] Total iron, expressed as ferrous oxide.

[5] Loss on ignition.

Table 3 (cont'd.)

Usable values, "complete analysis" (per cent, dry basis)

	USGS											
	Andesite AGV-1	Basalt BCR-1	Basalt BHVO-1*	Dunite DTS-1	Granite G-2	Grano-diorite GSP-1	Marine Mud MAG-1*	Perid-otite PCC-1	Quartz Latite QLO-1*	Rhyolite RGM-1*	Shale SCo-1*	
SiO_2	59.61	54.53	49.9 ?	40.61	69.22	67.32	50.9 ?	42.10	65.5 ?	73.4 ?	62.8 ?	SiO_2
TiO_2	1.06	2.26	2.7 ?	0.00?	0.48	0.66	0.73?	0.01	0.62?	0.27?	0.64?	TiO_2
Al_2O_3	17.19	13.72	13.7 ?	0.25	15.40	15.28	16.4 ?	0.73	16.2 ?	13.8 ?	13.6 ?	Al_2O_3
Fe_2O_3	4.56	3.48	2.7 ?	1.02?	1.07	1.70		2.54?	1.0 ?	0.5 ?		Fe_2O_3
FeO	2.03	8.96	8.5 ?	6.96?	1.44	2.32		5.17?	3.0 ?	1.2 ?		FeO
MnO	0.10	0.18	0.17?	0.12	0.03	0.04	0.10?	0.12	0.09?	0.04?	0.05?	MnO
MgO	1.52	3.68	7.2 ?	49.80	0.75	0.97	3.0 ?	43.50	1.0 ?	0.28?	2.6 ?	MgO
CaO	4.94	6.97	11.4 ?	0.14	1.96	2.03	1.35?	0.55	3.2 ?	1.1 ?	2.6 ?	CaO
Na_2O	4.32	3.30	2.3 ?	0.01?	4.06	2.81	3.8 ?	0.01	4.2 ?	4.1 ?	0.9 ?	Na_2O
K_2O	2.92	1.70	0.53?	0.00	4.46	5.51	3.6 ?	0.00	3.6 ?	4.3 ?	2.7 ?	K_2O
H_2O^+	0.78	0.67		0.42	0.50	0.58		4.70				H_2O^+
CO_2	0.02	0.02		0.07	0.08?	0.12		0.18				CO_2
P_2O_5	0.51	0.36	0.28?	0.00?	0.13	0.28		0.01				P_2O_5
F	0.04	0.05		0.00?	0.12	0.37		0.00?				F
S	0.01?	0.04?		0.00?	0.01?	0.03?		0.01?				S
Others[1]	0.32?	0.27?		0.93?	0.41?	0.42?		0.76?				Others[1]
Σ	99.93?	99.99?		100.31?	100.12?	100.44?		100.39?				Σ
O/F, S, Cl	0.03?	0.04?		0.00?	0.06?	0.18?		0.01?				O/F,S,Cl
Σ (corr.)	99.90?	99.95?		100.31?	100.06?	100.26?		100.38?				Σ (corr.)
Fe_2O_3, TR[2]	6.78	13.61	12.0 ?	8.70	2.69	4.30	6.8 ?	8.28	4.3 ?	1.9 ?	5.1 ?	Fe_2O_3, TR[2]
Fe_2O_3, TC[3]	6.82	13.66	12.1 ?	8.73?	2.67	4.28		8.29?	4.3 ?	1.8 ?		Fe_2O_3, TC[3]

[1] "Trace elements" (see Table 5), converted to oxides, where appropriate.

[2] Total iron, expressed as ferric oxide, derived from reported values for total iron.

[3] Total iron, expressed as ferric oxide, calculated from values derived for ferric and ferrous, based on reported values for ferric and ferrous.

[4] Incomplete.

Table 3 (cont'd.)

Usable values, "complete analysis" (per cent, dry basis)

	ZGI						LEN	IGI			
	Basalt BM	Feldspar Sand FK	Granite GM	Greisen GnA	Serpentine SW	Slate TB	Neph. Syenite NS-1	Albit. Granite SG-1A	Gabbro SGD-1A	Trap ST-1A	
SiO_2	49.60	88.15 ?	73.55	71.45	39.05	60.30	53.22	73.36	46.39	49.12	SiO_2
TiO_2	1.14	0.059?	0.213	0.023	0.016	0.93	0.71	1.05	0.072	1.71	1.82	TiO_2
Al_2O_3	16.20	6.22 ?	13.50	14.7	0.66	20.55	15.94	21.31	13.84	14.88	14.23	Al_2O_3
Fe_2O_3	1.60		0.75	1.70	5.2 ?	0.91	6.72 ?	2.31	0.68	3.86	3.92	Fe_2O_3
FeO	7.28		1.14	3.80	2.0 ?	5.43	0.66 ?	1.60	1.41	6.86	10.26	FeO
MnO	0.145	0.006?	0.166	0.083	0.032	0.04	0.006?	0.18	0.19	0.17	0.21	MnO
MgO	7.46	0.16 ?	0.377	0.033	38.5	1.94	1.77	0.64	0.054	7.09	5.74	MgO
CaO	6.46	0.12 ?	1.04	0.61	0.18	0.33	0.13	1.70	0.16	10.97 ?	10.24 ?	CaO
Na_2O	4.64	0.25 ?	3.76	0.08	0.013	1.31	0.09	9.85	5.46	2.82	2.49	Na_2O
K_2O	0.203	4.15 ?	4.74	2.63	0.016?	3.85	4.88	6.52	4.14	2.96	0.69	K_2O
H_2O^+	3.62	0.41 ?	0.349	1.8 ?	13.6	3.82	4.03	0.66	0.21	0.83	0.97	H_2O^+
CO_2	1.34	0.025?	0.278	0.04 ?	0.29 ?	0.13	0.04 ?	0.14?	0.073?	0.128	0.099	CO_2
P_2O_5	0.105	0.075?	0.063	0.016?	0.10	0.29	0.075?	0.28	0.013	1.01	0.21	P_2O_5
F	0.026?		0.067?	3.36	0.007?	0.071?	0.118?	0.14	0.30	0.12	0.032?	F
S				0.016?				0.01?	0.017	0.020	0.068	S
Others[1]	0.15 ?	0.02 ?	1.13?	0.68 ?	0.22 ?	1.89 ?	0.02 ?	0.34?	0.48 ?	0.63 ?	0.30 ?	Others[1]
Σ	99.97 ?	99.90 ?	100.00?	101.55 ?	100.32 ?	99.94 ?	100.04 ?	100.15?	100.44 ?	100.45 ?	100.36 ?	Σ
O/F, S, Cl	0.01 ?		0.03?	1.41 ?	0.00 ?	0.03 ?	0.05 ?	0.08?	0.13 ?	0.07 ?	0.06 ?	O/F, S, Cl
Σ (corr.)	99.96 ?	99.90 ?	99.97?	100.14 ?	100.32 ?	99.91 ?	99.99 ?	100.07?	100.31 ?	100.38 ?		Σ (corr.)
Fe_2O_3 TR[2]	9.68	0.26 ?	2.02	5.92	7.40	6.92	7.45	4.10	2.25	11.48	15.32	Fe_2O_3 TR[2]
Fe_2O_3 TC[3]	9.69		2.02	Note[4]		6.94	7.45	4.09	Note[4]			Fe_2O_3 TC[3]

[1] "Trace elements" (see Table 5), converted to oxides, where appropriate.

[2] Total iron, expressed as ferric oxide, derived from reported values for total iron.

[3] Total iron, expressed as ferric oxide, calculated from values derived for ferric and ferrous, based on reported values for ferric and ferrous.

[4] Method used to derive Fe_2O_3 values invalidates comparison.

Table 3 (cont'd.)

Usable values, "complete analysis" (per cent, dry basis)

	NBS										
	Bauxite 69a	Bauxite 69b	Potash Feldspar 70a	Glass Sand 81a[4]	Opal Glass 91	Flint Clay 97a	Plastic Clay 98a	Soda Feldspar 99a	Glass Sand 165a	Bauxite 697	Fly Ash 1633[4]	
SiO_2	6.01	13.4	67.1	(99.+)[5]	67.53	43.67	48.96	65.2	(99.+)[5]	6.80		SiO_2
TiO_2	2.78	2.0	0.01	0.12	0.019	1.90	1.61	0.007	0.011	2.6		TiO_2
Al_2O_3	55.0	49.3	17.9	0.66	6.01	38.79	33.19	20.5	0.059	45.7		Al_2O_3
Fe_2O_3												Fe_2O_3
FeO												FeO
MnO	0.02	0.09			0.008							MnO
MgO	0.02				0.008	0.15	0.42	0.02		0.35	0.064	MgO
CaO	0.29	0.12	0.11		10.48	0.11	0.31	2.14		0.17		CaO
Na_2O	0.00	0.03	2.55		8.48	0.037	0.082	6.2		0.60		Na_2O
K_2O	0.00	0.80	11.8		3.25	0.50	1.04	5.2		0.046		K_2O
L.O.I.	29.55	27.22	0.40		0.50 ?	13.32	12.44	0.26		0.07	2.07	L.O.I.
P_2O_5	0.08	0.12			0.022	0.36	0.11	0.02		22.2		P_2O_5
F					5.72					0.90		F
SO_3	0.04	0.63										SO_3
Others[1]	0.27?	0.04?	0.08?		0.38 ?	0.46 ?	0.21 ?	0.49		0.15		Others[1]
Σ	99.86?	100.85?	100.02?		102.49 ?	99.75 ?	99.69 ?	100.06 ?		0.22 ?		Σ
O/F, S, Cl	?	?	?		2.41 ?	?	?	?		99.81 ?		O/F, S, Cl
Σ (corr.)	99.86?	100.85?	100.02?		100.08 ?	99.75 ?	99.69 ?	100.06 ?		99.81 ?		Σ (corr.)
Fe_2O_3 TR[2]	5.8	7.1	0.075	0.082	0.081	0.45	1.34	0.065	0.012	20.0		Fe_2O_3 TR[2]
Fe_2O_3 TC[3]												Fe_2O_3 TC[3]

[1] "Trace elements" (see Table 5), converted to oxides, where appropriate.

[2] Total iron, expressed as ferric oxide, derived from reported values for total iron.

[3] Total iron, expressed as ferric oxide, calculated from values derived for ferric and ferrous, based on reported values for ferric and ferrous.

[4] Incomplete.

[5] Bracketed figures are not usable values; they are given as a mere general indication of composition.

Table 3 (cont'd.)

Usable values, "complete analysis" (per cent, dry basis)

	ASK		IRSID		CRPG					
	Larvikite ASK-1[5]	Schist ASK-2[5]	Bl. Furn. Slag ES-878-1	Ferrf. Marl MO8-1	Basalt BR	Granite GA	Granite GH	Biotite MicaFe	Phlogopite MicaMg	
SiO_2	(59.5)[4]	(56.2)	33.65	60.39	38.39	69.96	75.85	36.55	38.42?	SiO_2
TiO_2	(1.1)	(0.92)	0.619	0.714	2.61	0.38	0.08	2.51	1.64?	TiO_2
Al_2O_3	(18.6)	(18.8)	16.15	9.94	10.25	14.51	12.51	19.58	15.25?	Al_2O_3
Fe_2O_3				3.08	5.61	1.36	0.41	4.66	1.99?	Fe_2O_3
FeO				2.38	6.60	1.32	0.84	18.99	6.75?	FeO
MnO	0.13	0.04	1.268	0.057	0.20	0.09	0.05	0.35	0.26?	MnO
MgO	(1.1)	(2.0)	9.55	1.34	13.35	0.95	0.03	4.37	20.46?	MgO
CaO	(3.2)	(0.75)	35.65	8.70	13.87	2.45	0.69	0.43	0.08?	CaO
Na_2O	(6.5)	(0.8)	0.466	0.56?	3.07	3.55	3.85	0.30	0.12?	Na_2O
K_2O	(6.2)	(5.3)	1.7**	2.2 ?	1.41	4.03	4.76	8.79	10.03?	K_2O
H_2O^+				3.0 ?	2.31	0.87	0.46	2.92?	2.10?	H_2O^+
CO_2	(8.5)[7]			7.3 ?	0.86	0.11	0.14	0.19?	0.15?	CO_2
P_2O_5			0.034	0.016	1.05	0.12	0.01	0.45	0.01?	P_2O_5
F			0.109	0.016	0.10	0.05	0.35	1.59	2.86?	F
S			0.812	0.455	0.039	?	?			S
Others[1]			?	0.05 ?	0.56 ?	0.25?	0.13?	1.09?	0.80?	Others[1]
Σ			100.50?	100.17 ?	100.28 ?	100.00?	100.16?	100.97?	100.92?	Σ
O/F, S, Cl			1.03?	0.23 ?	0.07 ?	0.03 ?	0.15?	0.68?	1.22?	O/F, S, Cl
Σ (corr.)			99.47?	99.94 ?	100.21 ?	99.97 ?	100.01?	100.29?	99.70?	Σ (corr.)
Fe_2O_3 TR[2]	(4.6)	(6.9)	0.861	5.72	12.90	2.77	1.35	23.76	9.49?	Fe_2O_3 TR[2]
Fe_2O_3 TC[3]			Note[6]		12.94	2.83	1.36	Note[6]		Fe_2O_3 TC[3]

[1] "Trace elements" (see Table 5), converted to oxides, where appropriate.

[2] Total iron, expressed as ferric oxide, derived from reported values for total iron.

[3] Total iron, expressed as ferric oxide, calculated from values derived for ferric and ferrous, based on reported values for ferric and ferrous.

[4] Bracketed figures are not usable values; they are given as a mere general indication of composition.

[5] Incomplete.

[6] Method used to derive Fe_2O_3 values invalidates comparison.

[7] Total carbon.

	ANRT								IAEA	UNS		
	Bauxite BX-N	Diorite DR-N	Kyanite DT-N	Potash Feldspar FK-N	Glauco-nite GL-O[4]	Granite GS-N	Serpen-tine UB-N	Synth. Glass VS-N[5]	Soil SOIL-3[5]	Kaolin-ite KK	Glass Sand SS	
SiO_2	7.39	52.88	36.32	65.11	52.22	65.98	39.93	(55.30)[5]	(71)	47.06	99.35	SiO_2
TiO_2	2.41	1.10	1.40	0.02 ?	0.07 ?	0.68	0.12	(1.08)	(0.8)	0.166	0.036	TiO_2
Al_2O_3	56.53	17.56	59.21	18.64	7.75	14.71	2.97	(13.44)	15.47	36.77	0.249	Al_2O_3
Fe_2O_3	22.98	3.78	0.55	0.026?	17.61	1.93	5.46					Fe_2O_3
FeO	0.26	5.32	0.10	0.06 ?	2.25	1.66	2.69					FeO
MnO	0.05	0.21	0.008	0.005?	0.008?	0.056	0.12	0.09	0.11?	0.015	0.001?	MnO
MgO	0.11	4.47	0.04	0.01 ?	4.58	2.31	35.6 ?	(4.51)	(2.5)	0.192	0.007	MgO
CaO	0.17	7.09	0.04	0.11	0.98	2.51	1.18	(4.53)	(3.1)	0.236	0.030	CaO
Na_2O	0.06	3.00	0.04	2.58	0.04 ?	3.78	0.10	(3.95)	2.39	0.032	0.043	Na_2O
K_2O	0.07	1.73	0.12	12.83	8.16	4.64	0.02	(8.12)	2.24	1.063	0.057	K_2O
H_2O^+	11.69	2.20	0.95 ?	0.32 ?	5.72	1.07	11.28			12.75	0.169[9]	H_2O^+
CO_2	0.45?	0.15	0.62 ?[6]	0.085?		0.18 ?	0.44			0.174		CO_2
P_2O_5	0.13	0.25	0.09	0.024?	0.38	0.28	0.05	(0.02)	(0.2)	0.090		P_2O_5
F		?			0.13 ?	?						F
S	?	?				?				0.019		S
Others[1]	0.15?	0.20?	0.04 ?	0.14 ?	0.07 ?	0.33 ?	0.63?			0.22 ?	0.01 ?	Others[1]
Σ	100.48?	99.96?	99.73 ?	99.96 ?	99.99 ?	100.12 ?	100.39?			99.77 ?	99.99 ?	Σ
O/F, S, Cl	?	?			0.06 ?	?				0.01 ?		O/F, S, Cl
Σ (corr.)	100.48?	99.96?	99.73 ?	99.96 ?	99.93 ?	100.12 ?	100.39?			99.76 ?	99.99 ?	Σ (corr.)
Fe_2O_3 TR[2]	23.27	9.69	0.66	0.09	20.11	3.76	8.45	(4.14)	6.36?	0.982	0.038	Fe_2O_3 TR[2]
Fe_2O_3 TC[3]			Note[7]			3.77	Note[7]					Fe_2O_3 TC[3]

[1] "Trace elements" (see Table 5), converted to oxides, where appropriate.

[2] Total iron, expressed as ferric oxide, derived from reported values for total iron.

[3] Total iron, expressed as ferric oxide, calculated from values derived for ferric and ferrous, based on reported values for ferric and ferrous.

[4] Dried for 15 h.

[5] Bracketed figures are not usable values; they are given as a mere indication of composition.

[6] Non-carbonate carbon.

[7] Method used to derive Fe_2O_3 values invalidates comparison.

[8] Incomplete.

[9] Loss on ignition.

	BCS							QMC				
	Silica Brick 267	Silli-manite 309	"Pure" Silica 313	Bl. Furn. Slag 367	Soda Feldspar 375	Potash Feldspar 376	Iron Ore ES-681-1	Aplitic Granite I-1	Dolerite I-3	Pelitic Schist M-2	Calc-Silicate M-3	
SiO_2	95.9	34.1	99.6	34.4	67.1	67.1	17.8	75.36 ?	49.75?	48.88?	55.39?	SiO_2
TiO_2	0.17	1.92	0.022	0.75	0.38	0.01?	0.48	0.05	2.60	0.72	0.83	TiO_2
Al_2O_3	0.83	61.1	0.16	20.0	19.8	17.7	10.6	13.92 ?	13.07?	23.97?	17.62?	Al_2O_3
Fe_2O_3							37.81 ?	0.33 ?	5.09?	2.31?	0.91?	Fe_2O_3
FeO				1.00[4]			8.70 ?	0.20 ?	10.04?	6.30?	3.33?	FeO
MnO	0.15	0.03?	0.00	1.16			0.28	0.03	0.22	0.26	0.28	MnO
MgO	0.06	0.17	0.00	7.1	0.05?	0.03?	1.48	0.11	4.18	2.45	1.21	MgO
CaO	1.75	0.22	0.02	32.4	0.89		3.92	0.80	8.20	1.75	12.01?	CaO
Na_2O	0.06	0.36	0.00	0.44	10.4	2.83	0.092	4.59	2.92	1.60	2.98	Na_2O
K_2O	0.14	0.46	0.04	1.17	0.79	11.2	0.59	4.28	1.43	7.90	0.71	K_2O
L.O.I.		0.08?			0.39?	0.35?	10.24 ?	0.13 ?	1.71?	3.21?	0.78?	H_2O^+
							6.60 ?[5]	?	?	?	2.98?	CO_2
P_2O_5				0.14 ?			2.02	0.02 ?	0.40?	0.50?	0.36?	P_2O_5
F							0.19		0.07?	0.10?	0.06?	F
S				0.9%			0.103	0.005?				S
Others[1]						0.00?	0.23 ?	0.11 ?	0.30?	0.34?	0.16?	Others[1]
Σ	99.87?	99.93?	99.84 ?	99.50 ?	99.92?	99.32?	See text	99.96 ?	99.98?	100.09?	99.81?	Σ
O/F, S, Cl				See text					0.03?	0.04?	0.03?	O/F, S, Cl
Σ (corr.)	99.87?	99.93?	99.84 ?		99.92?	99.32?		99.94 ?	99.95?	100.05?	99.78?	Σ (corr.)
Fe_2O_3 TR[2]	0.79	1.51	0.025	1.11	0.12	0.10	47.48	0.54	16.22?	9.25	4.55	Fe_2O_3 TR[2]
Fe_2O_3 TC[3]							Note[6]	0.55 ?	16.25?	9.31?	4.61?	Fe_2O_3 TC[3]

[1] "Trace elements" (see Table 5), converted to oxides, where appropriate.

[2] Total iron, expressed as ferric oxide, derived from reported values for total iron.

[3] Total iron, expressed as ferric oxide, calculated from values derived for ferric and ferrous, based on reported values for ferric and ferrous.

[4] Total iron, expressed as ferrous oxide.

[5] Total carbon, expressed as carbon dioxide.

[6] Method used to derive Fe_2O_3 value invalidates comparison.

	GSJ		MRT	NIM						
	Basalt JB-1	Grano-diorite JG-1	Tonalite T-1	Dunite NIM-D	Granite NIM-G	Lujav-rite NIM-L	Norite NIM-N	Pyroxen-ite NIM-P	Syenite NIM-S	
SiO_2	52.60?	72.36	62.70	38.96	75.70	52.40	52.64	51.10	63.63	SiO_2
TiO_2	1.34	0.27	0.58	0.02	0.09	0.48	0.20	0.20	0.04	TiO_2
Al_2O_3	14.62	14.20	16.69	0.3?	12.08	13.69	16.50	4.18	17.34	Al_2O_3
Fe_2O_3	2.36	0.37	2.71	0.71	0.6?	8.74[4]	0.8?	1.02?[4]	1.07?[4]	Fe_2O_3
FeO	6.02	1.62	2.88	14.63	1.30	1.13	7.30[4]	10.59	0.30	FeO
MnO	0.15	0.06	0.10	0.22	0.02	0.77	0.18	0.22	0.01	MnO
MgO	7.76	0.76	1.89	43.31	0.06?	0.28	7.50	25.33	0.46	MgO
CaO	9.35	2.17	5.08	0.28	0.78	3.22	11.50	2.66	0.68	CaO
Na_2O	2.79	3.39	4.39	0.04?	3.36	8.37	2.46	0.37	0.43	Na_2O
K_2O	1.42	3.96	1.24	0.01?	4.99	5.51	0.25	0.09	15.35	K_2O
H_2O^+	1.01	0.54	1.52	0.30	0.49	2.31	0.33	0.26	0.22	H_2O^+
CO_2	0.18?	0.08?	0.07?	0.40?	0.10?	0.17	0.10?	0.08?	0.09	CO_2
P_2O_5	0.26	0.09	0.14	0.01?	0.01?	0.06	0.03	0.02	0.12	P_2O_5
F	0.04?	0.05?	0.05?	0.01?	0.42	0.44	0.03?	0.02?	0.01?	F
S	?	?	0.01?	0.02?	0.01?	0.065?	0.01?	0.02?	0.01?	S
Others[1]	0.28?	0.15?	0.19?	0.76?	0.19?	2.39?	0.12?	3.69?	0.34?	Others[1]
Σ	100.18?	100.07?	100.24?	100.19?	100.20?	99.98?	99.95?	99.85?	100.10?	Σ
O/F, S, Cl	0.02?	0.02?	0.03?	0.02?	0.19?	0.25?	0.02?	0.02?	0.01?	O/F, S, Cl
Σ (corr.)	100.16?	100.05?	100.21?	100.17?	100.01?	99.73?	99.93?	99.83?	100.09?	Σ (corr.)
Fe_2O_3 TR[2]	9.01	2.16	5.90	16.96[4]	2.02[4]	9.96[4]	8.91[4]	12.76[4]	1.40	Fe_2O_3 TR[2]
Fe_2O_3 TC[3]	9.05	2.17	5.91	16.97	2.04?	10.00[4]	8.89?[4]	12.79?[4]	1.40[4]	Fe_2O_3 TC[3]

[1] "Trace elements" (see Table 5), converted to oxides, where appropriate.

[2] Total iron, expressed as ferric oxide, derived from reported values for total iron.

[3] Total iron, expressed as ferric oxide, calculated from values derived for ferric and ferrous, based on reported values for ferric and ferrous.

[4] Not originators' values – see text.

	USGS				USGS-AEG						
	Mica Schist SDC-1[4]	Shale SGR-1[4,5]	Syenite STM-1[4]	Diabase W-1	Jasper-oid GXR-1[4]	Soil GXR-2[4]	"Deposit" GXR-3[4]	"Mill-head" GXR-4[4]	Soil GXR-5[4]	Soil GXR-6[4]	
SiO_2	66.0 ?	28.3 ?	59.5 ?	52.72	49.2	49.2	13.0	67.0	42.1	49.0	SiO_2
TiO_2	1.0 ?	0.26?	0.13?	1.07	0.11	0.47	0.17	0.43	0.35	0.83	TiO_2
Al_2O_3	16.0 ?	6.5 ?	18.5 ?	15.02	6.7	35.1		14.0	39.3	31.4	Al_2O_3
Fe_2O_3			2.9 ?	1.40							Fe_2O_3
FeO			2.1 ?	8.73							FeO
MnO	0.12?	0.03?	0.22?	0.17		0.12	2.9	0.02	0.04	0.13	MnO
MgO	1.7 ?	4.5 ?	0.1 ?	6.63	0.35	1.45	1.05	2.7	2.0	1.02	MgO
CaO	1.4 ?		1.1 ?	10.98	1.22	1.15	19.7	1.26	1.05	0.14	CaO
Na_2O	2.0 ?	3.0 ?	9.0 ?	2.15	0.07	0.75	1.05	0.71	1.04	0.14	Na_2O
K_2O	3.3 ?	1.6 ?	4.3 ?	0.64	0.06	1.70		5.2	0.99	2.5	K_2O
H_2O^+				0.53							H_2O^+
CO_2				0.06							CO_2
P_2O_5			0.16	0.14							P_2O_5
F				0.025							F
S				0.012?							S
Others[1]				0.21 ?							Others[1]
Σ				100.48?							Σ
O/F, S, Cl				0.02?							O/F, S, Cl
Σ (corr.)				100.46?							Σ (corr.)
Fe_2O_3 TR[2]	6.9 ?	3.2 ?	5.2 ?	11.11	33.3	2.7	26.6	4.2	4.6	8.0	Fe_2O_3 TR[2]
Fe_2O_3 TC[3]			5.2 ?	11.10							Fe_2O_3 TC[3]

[1] "Trace elements" (see Table 5), converted to oxides, where appropriate.

[2] Total iron, expressed as ferric oxide, derived from reported values for total iron.

[3] Total iron, expressed as ferric oxide, calculated from values derived for ferric and ferrous, based on reported values for ferric and ferrous.

[4] Incomplete.

[5] Contains major amounts of petroleum.

APPENDIX 3

EXAMPLE OF THE ANALYTICAL REQUEST FORM

Page 1 of _____

ANALYTICAL AND LAPIDARY SERVICES REQUEST

Analytical Sciences Laboratory
541 Superior Street, Victoria B.C., V8V 1X4
(604) 356-2134

Lab Batch Number _____

Number of Samples _____
Geologist/Project _____
Responsibility Number _____

Commitment Number _____
Spending Authority _____
Account Number _____

Date Samples Received _____
Date Preliminary Report _____
Date of Final Report _____

LAB NUMBER	SAMPLE NUMBER	NTS MAP SHEET	UTM ZN.	UTM EASTING	UTM NORTHING	MINFILE STRAT	CODE ROCK	SAMPLE TYPE	ANALYTICAL PACKAGE	MIN.	PULV. CODE	COST PER SAMPLE

Special Instructions :

Estimated Cost : _____

INSTRUCTIONS FOR USE OF SERVICES REQUEST FORM

Geologist/Project	Enter name and project
Spending Authority	Name of individual who will pay for the cost of services.
Number of samples	Enter total number submitted with request.
Responsibility Number	Responsibility Number of Spending Authority (*e.g.* 690 Environmental Geology)
Account Number	Account Number of Spending Authority (*e.g.* 06773 Analytical Sciences Laboratory)
Commitment Number	Entered by the Section Administrator when cost confirmed.
Sample Number	Field Sample Number (*e.g.* 91RL0001)
NTS Sheet Number	1:50,000 NTS Sheet Number
UTM Zone, Easting Northing	*e.g.* 10 665500 5465500
Minfile Strat Code	Use Minfile code in Appendix IV, Information Circular 1991-3 *e.g.* Nicola Group - 311
Minfile Rock Code	Use Minfile code in Appendix III of Information Circular 1991-3 *e.g.* Basalt - BSLT
Sample Type	Enter C-Channel/Chip; D-Drill Core F-Float; G-Grab; O-Other (Specify)
Analytical Package Code and Cost	Enter package code listed in Schedule. (*See* Summary below) **Note:** If individual elements only needed, enter package code followed by requested elements *e.g.* ASL 5 (Cr, Ba)
Min.	**Enter "M" if sample contains abundant sulphides and should be assayed for metals.**
Pulv.	Pulverization method. Enter either ASL 1 (Cr head) or ASL 2 (tungsten-carbide head)
Cost	Enter cost from the Fee Schedule. Costs will be confirmed in the Laboratory (*See* List Below).

CODE	METHOD	COST/SAMPLE($)
ASL 1	Pulverization in Cr-Steel mill	2.25
ASL 2	Pulverization in W Carbide mill	2.25
ASL 3	Sieving of soil and sediment)	0.50
ASL 4	Major oxides by XRF	10.00
ASL 5	Trace metals (all) by XRF	25.00
ASL 5	Trace metals (individual) by XRF	3.00
ASL 6	Trace metals (all) by AAS	10.00
ASL 6	Trace metals (individual) by AAS	2.00
ASL 7	Arsenic, antimony and mercury	5.00
ASL 7	Arsenic or antimony or mercury	2.00
ASL 8	Base metal assay	5.00
ASL 9	Loss on Ignition	3.00
ASL 10	Water at 105^{o}C	3.00
ASL 11	Carbon	5.00
ASL 12	Sulphur	5.00
ASL 13	Iron (FeO)	5.00
ASL 14	X-Ray Diffraction	10.00
ASL 15	Thin Sections	4.00
ASL 16	Photography (cost/hour)	15.00
CA 1	Gold by fire assay	8.00
CA 2	Gold plus 34 by INAA	12.00
CA 3	Trace elements and REE's by INAA	70.00
CA 4	REE's by INAA only	60.00
CA 5	Trace metals by ICP-ES	5.00
CA 6	As, Sb, Te, Se by ICP-ES	6.00
CA 7	Metal in water by ICP-ES	5.00

KEEP THE FIRST COPY OF THIS FORM FOR YOUR RECORDS AND SEND THE OTHER COPY WITH THE SAMPLES

APPENDIX 4

EXAMPLE OF THE ANALYTICAL SCIENCES LABORATORY TRACK SYSTEM FLOW SHEET

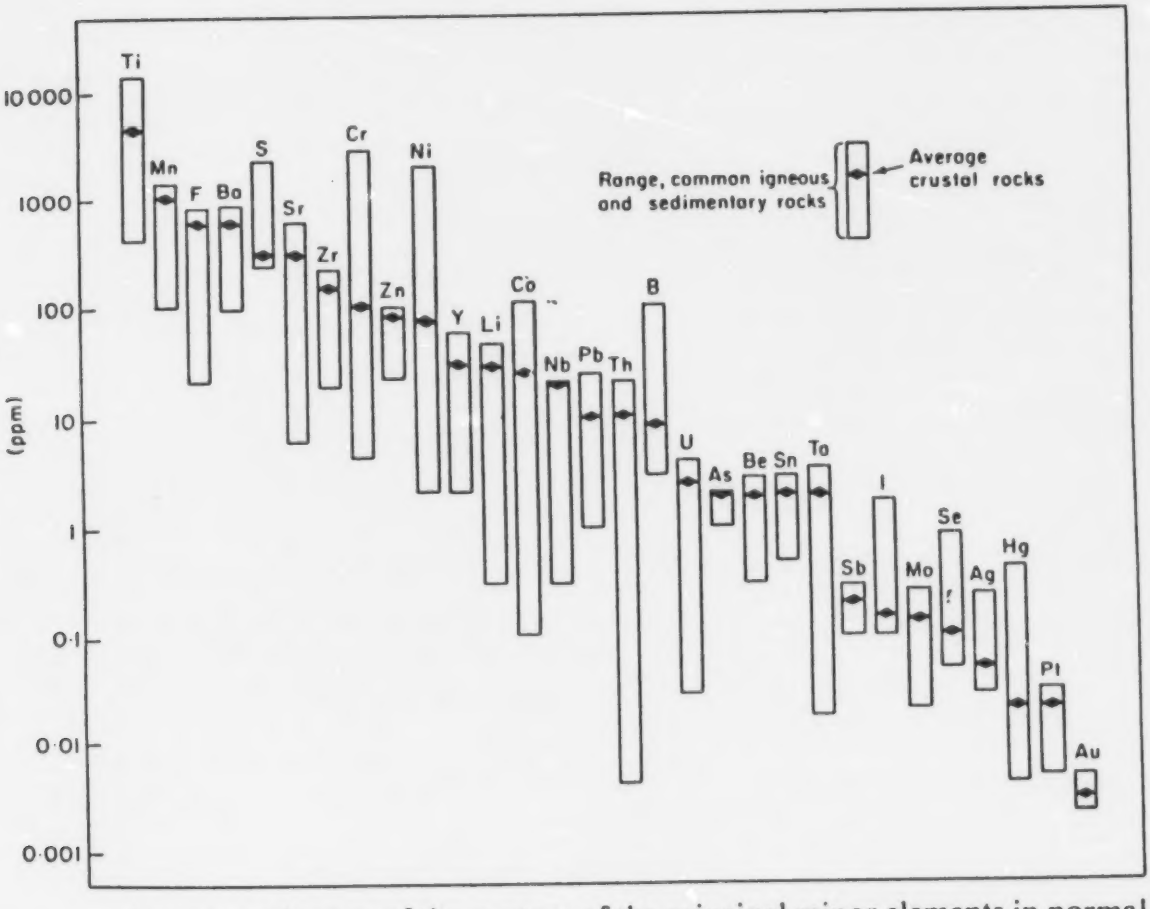
MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES
GEOLOGICAL SURVEY BRANCH LABORATORY

SAMPLE FLOWCHART

Date In	Batch	Lab Numbers From	To	Cly	Prep	Rej	Peripherals: Oxd	CO2	S	FeO	IRD Q	SQ	SPEC Q	SQ	IRIS SSRP	Au	Ag	Co	Pb	Zn	Cu	Mi	Mo	Cr	Mg	As	Sb	Ba	Sr	Nb	Bi	Zr	F	Wbl	Others	Date Out
08/16/89	89/097	039109	039119	GEA	W											111	111	111	111	111		111	111	111	111	111	111	111			111				Te Se Tel Tel	
					11											RC!	BB!	BB!	BB!	BB!		BB!	BB!	VV!	EC!	EC!	BB!	VV!			BB!				ACM ACM ACM ACM	10/30/90
08/16/89	89/098	039120	039128	GEA	S																9!														
					9																BB!															10/25/89
08/16/89	89/099	039129	039155	DRA	W											27!	27!	27!	27!	27!		27!	27!	27!	27!	27!	27!	27!								
					27											RC!	BB!	BB!	BB!	BB!		BB!	BB!	VV!	EC!	EC!	BB!	VV!								11/01/90
08/16/89	89/100	039156	039167	BCR							12!																								
					12						RC!																									02/21/90
08/16/89	89/101	039168	039169	DRA	W		2!	2!	2!	2!												2!		2!				2!	2!	2!		2!	2!	2!	B20-	
					2		VV!	BB!	BB!	EC!												BB!		VV!				VV!	VV!	VV!		VV!	VV!	VV!		11/08/90
08/16/89	89/102	039170	039172	DRA	S																3!														
					3																BB!															10/25/89
08/17/89	89/103	039173	039190	BCR							18!																								
					18						RC!																									02/21/90
08/18/89	89/104	33633E	.....	JBE																															
					6																														9	07/05/90
																																			BBC	
08/18/89	89/105	039191	039197	DRA	W											7!	7!	7!	7!	7!		7!	7!	7!	7!	7!	7!	7!								
					7											RC!	BB!	BB!	BB!	BB!		BB!	BB!	VV!	EC!	EC!	EC!	VV!								11/01/90
08/18/89	89/106	039198	039198	DPE							1!																								
					1						RC!																									09/06/89
08/18/89	89/107	039199	039200	DRA	W		2!	2!	2!	2!												2!		2!				2!	2!	2!		2!	2!	2!	B20-	
					2		VV!	BB!	BB!	EC!												BB!		VV!				VV!	VV!	VV!		VV!	VV!	VV!		11/08/90
08/18/89	89/108	039201	039202	DRA	S																2!														
					2																BB!															10/25/89
08/22/89	89/109	039203	039207	TSO	W											5!	5!	5!	5!	5!		5!	5!	5!		5!		5!	5!							
					5											RC!	BB!	BB!	BB!	BB!		BB!	BB!	VV!		EC!		VV!	VV!							10/31/90
08/23/89	89/110	039208	039213	DRA	W											6!	6!	6!	6!	6!		6!	6!	6!	6!	6!	6!	6!	6!							
					6											RC!	BB!	BB!	BB!	BB!		BB!	BB!	VV!	EC!	EC!	EC!	VV!	VV!							10/31/90
08/23/89	89/111	039214	039215	DRA	W		2!	2!	2!	2!												2!		2!				2!	2!	2!		2!	2!	2!	B20-	
					2		VV!	BB!	BB!	EC!												BB!		VV!				VV!	VV!	VV!		VV!	VV!	VV!		11/08/90
08/23/89	89/112	039216	039217	DRA	S																2!														
					2																BB!															10/25/89

APPENDIX 5

ELEMENTAL CRUSTAL ABUNDANCES



Average and range of the content of the principal minor elements in normal rocks.